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ADVISORY COMMITTEE ON ANIMAL FEEDINGSTUFFS

Fifth ACAF Meeting 27 June 2000 – Agenda Item 7

THE USE OF SWEET LUPINS IN ANIMAL FEED

Action required: The Committee is invited to raise any questions on the paper and, in particular, to consider the points raised in paragraph 18.

Secretariat June 2000

THE DEVELOPMENT OF LUPINS AS A FEED FOR RUMINANTS

1. A recent article in The Times ("Lupins may be farmers' alternative to GM chain") drew attention to the increasing interest, amongst farmers, in lupins as a source of animal feed protein in a GM-free food chain. The article claimed that 3,000 ha are likely to be planted in Britain this year, producing 5,000 tonnes of seed. This paper provides a background to the development of the crop in the UK and issues arising from it.

Background

2. The UK livestock industry relies heavily upon imported proteins feeds to complement home produced forages in the ration. This reliance on imported supplies has grown in recent years. The main imported protein feed is soya bean meal. In 1998 1 million tonnes of soya bean meal were imported and a further 0.8 million tonnes were generated by crushing soya beans in the UK (Buckingham, 1999). A further million tonnes of imported oilseed meals were used in compound feed manufacture in 1998, of which sunflower cake and meal accounted for about half. Almost half a million tonnes of maize gluten feed were also used, most of which was imported from N America. Rapeseed meal constitutes the main home-produced protein-rich feed (550 k tonnes used in compound feeds in 1998).

3. Lupins (*Lupinus* spp.) are grain legumes, the seeds of which contain relatively high protein contents (300 to 400 g kg^{-1} dry matter). A recent MAFF-sponsored study (Entec/Genus report, August 1997) confirmed that lupins have the potential to replace some of the imported protein feeds. This is now reflected in the objectives of the MAFF Livestock Research Programme LS36 (Improving the sustainability of livestock production through optimal nutrition). The objectives of this programme include the identification of new sources of nutrients and improving forage-based diets through the utilisation of legume varieties.

Lupins

4. Wild lupins, and those used in horticulture, are poisonous, containing high levels of toxic constituents. The most important of these are the alkaloids, which are found in all parts of the plant and are not destroyed by drying or storage, although they may be reduced when exposed to certain processes. In the seed, levels of 5 to 20 g kg-1 DM have been reported (Guillaume *et al.*, 1987). Other potentially toxic constituents include enzyme (trypsin) inhibitors and biochanin A, which has oestrogenic activity and may give rise to reproductive disorders.

5. Using conventional breeding techniques, varieties with low levels of alkaloids - known as sweet lupins - have been bred. Research, mainly in

Australia and Canada, confirmed the nutritional value of these indeterminate varieties of lupin. As a result, seeds from these genotypes are now widely used as a protein source in areas such as Eastern Europe and in Australia. However, these genotypes are generally not suited to Northern European climatic conditions.

6. Recently, determinate varieties have been bred which are both low in alkaloids and are suited to cultivation under UK conditions. In the UK, the species with the greatest potential protein yield (white lupin *Lupinus albus* L.) was formerly not suitable for seed production. However, Julier *et al*. (1993) demonstrated that autumn-sown white lupin genotypes with determinate plant architecture were appropriate for seed production in northern European conditions including the UK. These determinate genotypes have more reliable harvest dates and seed yields than the more traditional indeterminate genotypes. The first determinate white lupin variety (var. *Lucyane*) was tested under a wide range of agronomic treatments at IACR Rothamsted. The results of these studies were used to create a basic agronomic package on which to begin the commercial development of the UK lupin crop (Shield *et al*., 1996). The development of the crop continues at IACR Rothamsted under a MAFF-funded research programme (MAFF Project code AR0138). More recently dwarf determinate genotypes have been developed which have superior over-winter survival (Milford and Huyghe, 1996).

7. The narrow leafed lupin (*L. angustifolius*) and the yellow lupin (*L. luteus*) can also be successfully grown when spring-sown in the UK. Their potential protein yield is much less than the autumn-sown white lupin but they cost very little to grow and may even be produced under organic conditions.

8. Siddons *et al*. (1994) calculated that 130,000 ha were available annually for lupin production in England and Wales. This area is only slightly smaller than the average annual total area of peas and beans.

9. To date there has been limited research on the nutritional value of determinate varieties of lupins as feeds for farm livestock:

10. *Monogastrics:* The nutritional value of lupins is limited by their content of non-structural polysaccharides. However, enzyme supplementation has been shown to improve the nutritional value of the feeds, and enzyme-treated lupins have been fed successfully to broilers as the sole feed.

11. *Ruminants:* Studies funded by MAFF and the MDC have confirmed that the nutritional characteristics of determinate lupins are similar to indeterminate varieties, with some evidence that the protein quality is slightly better. Other studies have indicated that determinate lupins have no adverse effect

on either milk production by dairy cows or growth rates in young bulls, and may be used as an alternative to soyabean meal.

Forage lupins

12. Most lupins currently being grown will be harvested for their seed for use in diets for both ruminants and monogastric farm animals. However, there is increasing interest in growing lupins as a forage crop for ensiling, and subsequent use as a feed for ruminants. Some varieties of lupins are susceptible to a fungal disease, *Phomopsis* stem blight, in which the fungus produces a mycotoxin. Phomopsis was found on at least one crop in the UK last year, although there is no evidence that farm livestock have been affected. There are however a number of reports - particularly from Australia - of ruminant animals dying after consuming forage lupin or lupin stubble that had been infected with this fungus.

13. The potential of forage lupins in the UK is the subject of a recently commissioned MAFF Bridge-LINK Project. (LS3606).

Benefits to UK agriculture and consumers

14. It would appear that the new determinate varieties have considerable potential as a source of protein for ruminant livestock and offer a number of advantages to UK agriculture and consumers of animal products.

- **Environmental:** Lupins may be produced in the UK under low input or organic systems. Furthermore, reliance on fish meal based proteins may have a negative environmental impact in some sensitive eco-systems.

- **Financial:** The UK dairy industry relies on imported proteins. Prices fluctuate considerably according to international demand, but are generally linked to prices for soyabean meal. These are currently at record lows of around £140/tonne, but are expected to rise significantly as a result of climatic conditions in N America.

- **Consumer choice and safety:** The inclusion of animal-derived proteins in the diet of dairy cows is being questioned by consumers. In addition, many of the imported protein supplements, notably soyabean meal, cottonseed meal and maize gluten feed may be derived from genetically modified (GM) crops. Premiums for GM free proteins of between 10-100% are reported depending on crop, country of origin, transport and the storage involved. Greater production and utilisation of lupin seed and forages crops on UK farms affords the opportunity to increase the traceability of feed proteins for farm animals and offer a source of non-GM protein feed.

- **Consumer health:** There may be benefits to human health if characteristics of lupin seeds are transferred into animal fats. Lupin seeds typically contain 90-110 g oil kg^{-1} in the dry matter, and the oil has a favourable n3:n6 ratio. The potential for transfer of these to animal products requires further investigation.

Summary

15. Recent breeding programmes have succeeded in producing determinate varieties of lupins that are both capable of being grown under UK conditions and contain low levels of the known anti-nutritional substances factors present wild varieties.

16. Research has confirmed that determinate varieties have similar nutritional characteristics to determinate varieties that are widely used as animal feeds in other parts of the world.

17. Forage lupins, grown as forages for ruminant livestock, may be susceptible to fungal disease. This could pose a risk to livestock consuming the forage.

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Action

18. Many new varieties of crops with enhanced agronomic or nutritional characteristics have been produced by conventional plant breeding programmes. However, most of these, e.g. cereals, have a long history of safe use. In contrast, lupins are derived from a variety of plants that are known to contain a number of toxins. This raises a number of issues that the Committee is invited to consider:

- **The safety of lupins to farm livestock:** The new determinate varieties of lupin were developed about a decade ago, and since then they have been grown under a variety of different environmental and agronomic conditions. Is this an adequate period in which to test the stability of the new genetic structure? What is the possibility that those anti-nutritional substances currently present at low levels might be expressed at higher levels over time? Then there is the risk of cross-pollination with ornamental lines. Is there a particular risk of this is occurring with

home-saved seeds? Is there a need for an on-going monitoring programme?

- **Transfer of anti-nutritional substances of livestock products (milk, meat and eggs):** Changes in the genetic make-up of the determinate varieties could have altered absorption of anti-nutritional substances to milk, meat or eggs? Even though any digestion or metabolism of the anti-nutritional substances may have occurred at very low levels, does this require closer examination?

- **Enhancing the nutritional value of livestock products:** There may be a need to study the extent to which the nutritional characteristics, and in particular those of the oil, transfer to animal products, and whether they pose a benefit (or risk) to human health.

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